Component Procedures: Variable Valve Timing Actuator

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Parts and Labor (itype_189)

Parts

Qualifier	Part #	Name	Price	Note
Actuator > Intake > Right	12655855	21 - Actuator	0.00	
Actuator > Intake > Left	12655856	21 - Front Cover	841.74	
Actuator > Exhaust	12614464	21 - Actuator	171.54	

Labor

Operation	Qualifier Path	Skill	Std Hrs	Wty Hrs
Remove & Replace	Variable Valve Timing > Actuator, R&R > Left ?	B	6.7	4.3
Remove & Replace	Variable Valve Timing > Actuator, R&R > Left ?	B	6.7	4.3
Remove & Replace	Variable Valve Timing > Actuator, R&R > Right?	B	6.4	4.1
Remove & Replace	Variable Valve Timing > Actuator, R&R > Right?	B	6.4	4.1

Camshaft Position Actuator Replacement - Bank 1 (Article 12160)

Special Tools
- EN49982-1 - Timing Chain Retainer
- EN49982-2 - Timing Chain Retainer
For equivalent regional tools, refer to Special Tools .
Removal Procedure
- Remove the camshaft cover . Refer to Camshaft Cover Replacement - Right Side .
- Remove the camshaft position actuator solenoid valve solenoid – intake. Refer to Camshaft Position Actuator Valve Solenoid Replacement - Bank 1 (Right Side) Intake .
- Remove the intake camshaft position sensor . Refer to Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake .
- Remove the exhaust camshaft position sensor . Refer to Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust .
- Remove the camshaft position actuator solenoid valve solenoid – exhaust. Refer to Camshaft Position Actuator Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust .
- Rotate engine clockwise using crankshaft dampener retaining bolt until the flats at the rear ends of the camshafts are pointing up. This puts the camshafts on “base circle” and will reduce their tendency to rotate from valve spring pressure when the camshaft position actuators/drive chains are removed.
- Loosen intake and/or exhaust camshaft position actuator retaining bolts, depending on which camshaft position actuator and/or camshaft you will be servicing. If servicing both camshaft position actuators and/or camshafts, loosen both bolts.
- Mark the position of the chain to the camshaft position actuator – intake. Click for full-size image
- Mark the position of the chain to the camshaft position actuator – exhaust. Click for full-size image
- Remove camshaft front cap bolts (1). Click for full-size image
- Remove the camshaft front cap (1). Click for full-size image
- Loosen wingnut (4) to open the clamping area of EN49982-1 - retainer . Click for full-size image
- Install EN49982-1 - retainer intake side chain holder onto front cover by screwing in the thumbscrew (2) on the EN49982-1 - retainer finger -tight. Click for full-size image
- Tighten wingnut (4) so EN49982-1 - retainer closes over and firmly grasps timing chain. Click for full-size image
- EN49982-2 - retainer (1) will be installed in the following steps such that it wedges between an internal rib (2) that is cast into the inside of the front cover (shown in dotted line above) and the timing chain and spring-loaded tensioner shoe (3), holding the chain in position. The wedge will be left in place during the cam position actuator and/or camshaft service. Click for full-size image
- Insert the EN49982-2 - retainer between the two camshaft position actuators with the “teeth” on the EN49982-2 - retainer facing toward the front cover. Click for full-size image
- Once the wedge portion of EN49982-2 - retainer is below the camshaft position actuators, rotate the EN49982-2 - retainer until the flat in the handle faces toward the intake camshaft position actuator. This orients the “teeth” toward the chain. Click for full-size image
- Drop the wedge down until it begins to engage the timing chain and the belt casting (2). Click for full-size image

- If possible shine a strong light down from above, between the camshaft position actuators, and see the wedge in overall position as shown in the above graphic. Click for full-size image
- Using a 20 mm wrench on the cast hexagonal portion of the exhaust camshaft, rotate the camshaft toward the intake camshaft while pushing down on the handle of the EN49982-2 - retainer . Click for full-size image
- This rotation of the camshaft will compress the tensioner shoe (3) against the spring force of the tensioner, opening up a gap between the chain and the internal rib in the front cover. The wedge will then drop into this gap. You will feel a distinct click as the teeth engage the chain. Click for full-size image
- Release the force on the wrench, allowing the spring tension to close the tensioner shoe against the wedge portion of EN49982-2 - retainer . You should be able to lightly tug on the EN49982-2 - retainer and it should stay in position. Repeat Steps 20 and 21 if necessary to re-insert the EN49982-2 - retainer until you are certain it is in position and will stay in position. Click for full-size image
- With EN49982-2 - retainer in position and with the 20 mm wrench removed, there should now be some slack in the timing drive chain as indicated in the graphics shown. Click for full-size image
- Do not pry against the face of the camshaft position actuators or the position actuator retaining bolt. Click for full-size image
- Position a screwdriver or small pry bar between a camshaft cap and camshaft lobe. Carefully move/pry the camshafts as far as possible toward the rear/flywheel end of the engine. Click for full-size image
- The EN49982-1 - retainer and EN49982-2 - retainer should be in position as shown, they must be left in position during the servicing of the camshaft position actuator(s) and/or camshaft(s). Click for full-size image
- To remove the intake camshaft position actuator, remove the loosened retaining bolt. To remove only the exhaust camshaft position actuator, skip the steps for removing the intake camshaft position actuator. However, the EN49982-1 - retainer MUST be installed as discussed even if the intake side will not be serviced or the timing of the camshaft chains will be lost. Click for full-size image
- Slide the camshaft position actuator forward and off the end of the intake camshaft. The slot in the EN49982-1 - retainer will allow the tool to move forward enough to disengage the camshaft position actuator from the front of the camshaft. Remove the plastic thrust washer when removing the camshaft position actuator from the end of the camshaft. Click for full-size image
- Tilt the camshaft position actuator forward and out/away from the engine. Click for full-size image
- Allow the chain to rest on the EN49982-1 - retainer and EN49982-2 - retainer in position during service.

Installation Procedure

- It may help to carefully pry the camshaft forward and to move the EN49982-1 - retainer backward via the slot to reengage the position actuator to the camshaft. The dowel pin on the camshaft position actuator must be aligned with the slot in the camshaft nose for reassembly. Click for full-size image
- Install the intake camshaft position actuator first by inserting the actuator between the timing chain and front cover. Tilt the actuator in and engage the chain while aligning the marks you made on the chain and position actuator. Click for full-size image
- Ensure the camshaft position actuator fits snugly to the end of the camshaft. Click for full-size image
- Install the intake camshaft position actuator retaining bolt, and lightly tighten the bolt to hold the camshaft actuator in place. DO NOT torque at this time.
- Install the exhaust camshaft position actuator retaining bolt, and lightly tighten the bolt to hold the camshaft actuator in place. DO NOT torque at this time.
- Double-check that the marks on both the intake and exhaust camshaft position actuators to ensure that they are aligned with their respective paint marks on the chain.
- Using a 20 mm wrench on the cast hexagonal portion of the exhaust camshaft, rotate the camshaft clockwise while pulling up on the handle of the EN49982-2 - retainer . Click for full-size image
- Remove EN49982-2 retainer.
- Release the pressure on the wrench. The timing chain should now be tight and should lose the slack the wedge was providing.
- Torque one or both camshaft position actuator retaining bolts to 58 Nm (43 lb ft) .
- Unscrew the wingnut on EN49982-1 - retainer to release timing chain, and then remove EN49982-1 - retainer from the front cover by unscrewing the thumbscrew (2). Click for full-size image
- Install camshaft front cap and bolts (1). Click for full-size image
- Tighten the camshaft front cap outer bolts to 10 Nm (89 lb in) .
- Tighten the camshaft front cap inner bolts to 10 Nm (89 lb in) .
- Install the camshaft position actuator solenoid valve solenoid – exhaust. Refer to Camshaft Position Actuator Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust .
- Install the camshaft position actuator solenoid valve solenoid-intake. Refer to Camshaft Position Actuator Valve Solenoid Replacement - Bank 1 (Right Side) Intake .
- Install the intake camshaft position sensor s. Refer to Camshaft Position Sensor Replacement - Bank 1 (Right

Side) Intake .
- Install the exhaust camshaft position sensor. Refer to Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust .
- Install the camshaft cover. Refer to Camshaft Cover Replacement - Right Side .

Camshaft Position Actuator Replacement - Bank 2 (Article 12161)

Special Tools
EN-48313 - Timing Chain Retention Tool
For equivalent regional tools, refer to Special Tools .
Removal Procedure
- Remove the left camshaft cover . Refer to Camshaft Cover Replacement - Left Side . Click for full-size image
- Remove the left intake and exhaust camshaft position sensor s. Refer to Camshaft Position Sensor Replacement
- Bank 2 (Left Side) Intake and Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust .
- Remove the left intake and exhaust camshaft position actuator solenoids. Refer to Camshaft Position Actuator Valve Solenoid Replacement - Bank 2 (Left Side) Intake and Camshaft Position Actuator Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust .
- Rotate the crankshaft balancer using the balancer bolt until the camshafts are in a neutral (low tension) position. The camshafts will be parallel with the camshaft cover rail (1).
- Use a paint stick to create an alignment mark on one of the timing chain links (2) and the adjacent tooth on the exhaust camshaft position actuator (1). Click for full-size image
- Use a paint stick to create an alignment mark on one of the timing chain links (3) and the adjacent tooth on the intake camshaft position actuator (4).
- Use an open end wrench on the hex cast into the left intake and exhaust camshafts and rotate the camshafts toward each other in order to create slack in the chain between the actuators.
- Unscrew the EN-48313 - tool so that the legs of the tool are retracted. Click for full-size image
- Insert the EN-48313 - tool between the camshaft actuator s, rearward of the timing chain until the bottom line that is scribed in the body of the tool (2) is adjacent to the top surface of the cylinder head (1). This is the approximate installed position.
- Ensure that the feet (4) on the legs of the tool are facing the front of the engine. Click for full-size image
- Partially expand the legs (1, 3) of the EN-48313 - tool by turning the T-shaped handle clockwise.
- Insert the leg of the tool (1) behind the timing chain guide (2).
- Continue expanding the EN-48313 - tool until the legs (1, 3) contact the timing chain. Do not tighten at this time.
- Hand tighten the EN-48313 - tool . Click for full-size image
- The EN-48313 - tool is now properly installed to hold the timing chain in position. Click for full-size image
- Use an open end wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening the camshaft position actuator bolt. Click for full-size image
- If replacing the exhaust camshaft position actuator, then remove the bolt and the actuator.
- If replacing the intake camshaft position actuator, then remove the bolt and the actuator.
- If removing both the exhaust and intake camshaft actuators, the timing chain can be draped over the EN-48313 - tool once the actuators have been removed.
- Rotate the actuator in order to align the opening in the actuator reluctor wheel with the cam sensor boss in the front cover, to allow actuator removal.
- Remove the camshaft thrust washer.
Installation Procedure
- Align the exhaust camshaft actuator alignment mark (1) to the timing chain alignment mark (2) made during disassembly. Click for full-size image
- Ensure that the intake camshaft actuator alignment mark (4) and the timing chain alignment mark (3) are also aligned.
- Position the exhaust camshaft actuator to the camshaft and install the actuator bolt hand tight.
- Remove the EN-48313 - tool .
- The camshaft position actuator will vary depending on application.
- Camshaft thrust washers must only be installed on applications that had thrust washers present during removal of the camshaft position actuators. Do not install washers on applications if they are not already present.
- If equipped, ensure the proper camshaft thrust washer is used. Use a 1.6 mm (0.063 in) thrust washer on applications that have 5 attaching screws on the back side of the camshaft position actuator (1). Use a 1.1 mm (0.043 in) thick thrust washer with yellow speckles on applications that have 4 attaching screws on the back

side of the camshaft position actuator (2). Click for full-size image
- Install the thrust washer, if applicable.
- If the exhaust camshaft position actuator has been replaced, then tighten the bolt to 58 Nm (43 lb ft) .
Click for full-size image
- If the intake camshaft position actuator has been replaced, then tighten the bolt to 58 Nm (43 lb ft) .
- If both the exhaust and intake has been replaced, then tighten bolt to 58 Nm (43 lb ft) .
- Install the left intake and exhaust camshaft position actuator solenoid s. Refer to Camshaft Position Actuator Valve Solenoid Replacement - Bank 2 (Left Side) Intake and Camshaft Position Actuator Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust .
- Install the left intake and exhaust camshaft position sensor s. Refer to Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake and Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust .
- Install the left camshaft cover. Refer to Camshaft Cover Replacement - Left Side .

Camshaft Position Actuator Valve Solenoid Replacement - Bank 1 (Right Side) Intake (Article 11401)

Removal Procedure
- Turn the ignition OFF.
- Remove the power brake booster auxiliary pump. Refer to Power Brake Booster Auxiliary Pump Replacement .
- Remove the camshaft position (CMP) actuator valve electrical connector (1) from the CMP sensor (2). Click for full-size image
- Remove the CMP actuator solenoid valve to engine front cover retaining bolt (1). Click for full-size image
- Remove the CMP actuator valve (2) from the engine front cover.
- Inspect the CMP actuator valve seal and replace as necessary.

Installation Procedure
- Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.
- Install the CMP actuator valve (2) to the engine front cover . Click for full-size image
- Install the CMP actuator solenoid valve to engine front cover retaining bolt (1) and tighten to 9 Nm (80 lb in) .
- Install the CMP actuator valve electrical connector (1) to the CMP sensor (2). Click for full-size image
- Install the power brake booster auxiliary pump. Refer to Power Brake Booster Auxiliary Pump Replacement .

Camshaft Position Actuator Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust (Article 11399)

Removal Procedure
- Turn the ignition OFF.
- Remove the power brake booster auxiliary pump. Refer to Power Brake Booster Auxiliary Pump Replacement .
- Remove the camshaft position (CMP) actuator valve electrical connector (1) from the CMP (2). Click for full-size image
- Remove the CMP actuator solenoid valve to engine front cover retaining bolt (1). Click for full-size image
- Remove the CMP actuator valve (2).
- Inspect the CMP actuator valve seal and replace as necessary.

Installation Procedure
- Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.
- Install the CMP actuator valve (2) to the engine front cover. Click for full-size image
- Install the CMP actuator solenoid valve to engine front cover retaining bolt (1). Tighten Tighten the bolt to 9 Nm (80 lb in).
Tighten the bolt to 9 Nm (80 lb in).
- Install the CMP valve electrical connector (1) to the CMP actuator valve. Click for full-size image
- Install the power brake booster auxiliary pump. Refer to Power Brake Booster Auxiliary Pump Replacement .

Camshaft Position Actuator Valve Solenoid Replacement - Bank 2 (Left Side) Intake (Article 11405)

Removal Procedure
- Turn the ignition OFF.
- Remove the power steering fluid reservoir bolts and reposition the power steering fluid reservoir in order to provide access. Refer to Power Steering Fluid Reservoir Replacement .
- Remove the camshaft position (CMP) actuator valve electrical connector (1) from the CMP actuator (2).
Click for full-size image

- Remove the CMP actuator solenoid valve to engine front cover retaining bolt (1). Click for full-size image
- Remove the CMP actuator valve (2) from the engine front cover.
- Inspect the CMP actuator valve seal for damage and replace as necessary.

Installation Procedure

- Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.
- Install the CMP actuator valve (2) to the engine front cover . Click for full-size image
- Install the CMP actuator solenoid valve to engine front cover retaining bolt (1) and tighten to 9 Nm (80 lb in) .
- Install the CMP actuator valve electrical connector (1) to the CMP actuator valve (2). Click for full-size image
- Install the power steering fluid reservoir. Refer to Power Steering Fluid Reservoir Replacement .

Camshaft Position Actuator Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust (Article 11403)

Removal Procedure

- Ignition OFF.
- Remove the intake manifold cover . Refer to Intake Manifold Cover Replacement - Front .
- Use compressed air to remove debris from the camshaft position (CMP) actuator solenoid valve and surrounding cavities. Click for full-size image
- Remove the CMP actuator solenoid valve electrical connector (1) from the CMP actuator solenoid valve (2).
- Remove the CMP actuator solenoid valve to engine front cover retaining bolt (3).
- Remove the CMP actuator solenoid valve (2) from the engine.

Installation Procedure

- Inspect the CMP actuator solenoid valve seal for damage. Replace the CMP actuator solenoid valve seal if necessary. Refer Engine Front Cover Disassemble
- Install the CMP actuator solenoid valve (2) to the engine. Click for full-size image
- Install the CMP actuator solenoid valve to engine front cover retaining bolt (3) and tighten to 9 Nm (80 lb in) .
- Connect the CMP actuator solenoid valve electrical connector (1) to the CMP actuator solenoid valve (2).
- Install the intake manifold cover. Refer to Intake Manifold Cover Replacement - Front .